ACCURACY OF BACK-FAT PROBES, SCORES FOR MARKET GRADE, AND VARIOUS BODY MEASUREMENTS ON LIVE HOGS FOR PREDICTING CARCASS VALUE

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Accuracy of Back-Fat Probes, Scores for Market Grade, and Various Body Measurements on Live Hogs for Predicting Carcass Value

By J. X. King, H. O. Hetzer, and J. H. Zeller, *Animal Husbandry Research Division, Agricultural Research Service*[1]

Meat-type breeding stock and market hogs yielding larger amounts of lean cuts with less fat are increasingly in demand. Some simple objective measurements on live hogs are needed for accurately predicting carcass value. Such measurements might enable a breeder to identify superior meat-type hogs at lighter weights than is now possible, and thus the efficiency of his program would be increased.

Although back-fat measurements are generally considered to be more accurate for estimating carcass composition than other live-hog measurements, few if any direct comparisons have been made of the relative accuracy of these methods. The primary purpose of this study was to determine the relative accuracy of back-fat probes, scores for market grade, and various linear body measurements on live hogs for predicting carcass value.

REVIEW OF LITERATURE

In several studies back-fat thickness, scores for market grade, and external body measurements on live hogs have been shown to be related to carcass value. Hetzer et al. (*1950*)[2] found that 40 to 45 percent of the variation in yield of five preferred cuts and in yield of lean meat in ham could be explained on the basis of eight live-hog measurements, which were obtained on 141 animals at 225 pounds. Although the various measurements taken separately had rather low predictive values, certain combinations offered possibilities for predicting carcass yields with fair accuracy.

Robison et al. (*1960*) studied nine live-hog measurements and individual weights of 663 animals at ages ranging from 84 to 154 days in relation to carcass yields. They concluded that back-fat thickness at the loin and the weight when hogs are 154 days old may be used for predicting fairly accurately the yield of lean cuts. About 42 percent of the variation in yield of lean cuts was accounted for when the

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[2] References to Literature Cited (page 16) are herein indicated by the name of the author or authors followed by the year of publication in italics.

weight and back-fat thickness at 154 days were used as compared with 50 percent when all the measurements were used.

Bratzler and Margerum (*1953*) studied the accuracy of three judges' scores for predicting carcass length, carcass back-fat thickness, and yield of preferred cuts. The judges scored 434 hogs weighing 181 to 240 pounds. Although they differed slightly in their predictions, their estimates generally were most accurate for the lighter weight hogs. The correlations between the judges' scores and the respective measurements of the three items were 0.6, 0.5, and 0.3 for the 181- to 200-pound group, 0.4, 0.4, and 0.1 for the 201- to 220-pound group, and 0.2, 0.3, and 0.2 for the 221- to 240-pound group. Bratzler and Margerum concluded from these results that considerable training and experience would be necessary before hogs could be accurately graded according to the official U.S. standards for grades of slaughter swine.

More recently Tuma et al. (*1958*) studied the relationship between six judges' scores for predicting carcass length, carcass back-fat thickness, and yield of lean cuts of 39 barrows and the actual carcass measurements. The correlations for the three items ranged from 0.37 to 0.82, from 0.36 to 0.73, and from 0.07 to 0.25, respectively.

Live-hog back-fat measurements for predicting carcass yields were first used by Hazel and Kline (*1952*). They reported a correlation of 0.81 between the average of four back-fat measurements on 96 live hogs and those on the 96 carcasses. The correlations obtained for yield of primal cuts with the live-hog and the carcass back-fat measurements were -0.50 and -0.45, respectively. The same workers (*1953*) studied the accuracy of eight probing sites on live hogs for estimating carcass fatness and leanness. They found that the most accurate locations were behind the shoulders, over the loin, and at the top of the ham.

Hetzer et al. (*1956*) obtained back-fat measurements on 140 live hogs weighing 150, 175, 200, and 225 pounds. They reported that these measurements on live hogs at 175 and 225 pounds were generally as accurate for predicting carcass value as were carcass back-fat measurements. De Pape and Whatley (*1956*) found that back-fat measurements taken at heavier weights tended to be more accurate indicators of carcass value than those taken at lighter weights. Additional references on various techniques for estimating carcass value in swine may be found in a report by Harrington (*1958*).

MATERIALS AND METHODS

Measurements of back-fat thickness, scores for market grade, and various body measurements were obtained during the spring and summer of 1958 on 107 crossbred hogs in Record-of-Performance feeding trials at the U.S. Agricultural Research Center, Beltsville, Md. The 107 hogs—53 barrows and 54 gilts—were from 61 litters sired by 29 boars. They consisted of reciprocal crosses between combinations of three noninbred and three inbred stocks.

Live-hog measurements were obtained for the following items: (1) Back-fat thickness, (2) score for market grade, (3) circumference at chest, (4) length of body from ear to tail, (5) height at shoulders, (6) width at shoulders, (7) width of middle, (8) width over ham,

(9) depth at chest, and (10) depth of middle. All measurements were taken on each hog by two men when the animals weighed approximately 75, 125, and 225 pounds. Daily gain was calculated from the weight at 56 days to each of these three weights. The inclusion of daily gain and live weight at slaughter brought the number of live-hog measurements to 12. The actual average weights of the hogs when measured were 74.5±0.2, 125.4±0.2, and 224.7±0.3 pounds. The ages of the hogs at these weights averaged 88, 122, and 181 days, respectively.

To facilitate measuring, each hog was restrained with the loop of a wire hog catcher placed around the maxilla. Back-fat thickness was measured to the nearest one-tenth inch with a lean meter as described by Andrews and Whaley (*1955, pp. 27–29*). These measurements were taken by each man on opposite sides of the animal. The back-fat probes were made about 2 inches off the midline of the back at the following sites: (1) Immediately behind the shoulders, (2) at the middle of the back, and (3) directly over the flank.

Scores for market grade were based on U.S. Department of Agriculture (*1952*) standards. Hogs were graded prior to probing in order that back-fat thickness would not be a factor in establishing the market grade. The grades ranged from 1 to 6; 1 to 3 represented U.S. No. 1 and 4 to 6 represented U.S. No. 2 hogs.

The body measurements were taken to the nearest one-tenth centimeter in accordance with the methods described by Phillips and Dawson (*1936*). All means, standard deviations, and regression coefficients based on these measurements were subsequently converted to inches.

Each hog was removed from the feeding trials when it weighed approximately 225 pounds. It was deprived of feed but allowed access to water for 24 hours prior to slaughter. Live weight at slaughter varied from 204 to 220 pounds. Slaughtering and cutting were done according to the procedures described by Hankins and Hiner (*1937*) and Hiner (*1949*). After the carcasses were chilled for approximately 72 hours, they were divided into a full-cut head, two rib picnic shoulders, butts, plates, square-cut unskinned hams, loins with one-fourth inch, on an average, of fat left on, and bellies trimmed just above the teat line and squared at the shoulders, back, and flank end. All cuts were weighed to the nearest one-tenth pound, and the yield of each cut was expressed as a percentage of live weight at slaughter.

The carcass traits studied were as follows: (1) Yield of lean cuts, the combined yield of hams, loins, picnic shoulders, and shoulder butts; (2) yield of fat cuts, the combined yield of back fat, leaf fat, plates, and fat trimmings; (3) loin-eye area, measured in square inches by a planimeter reading of a tracing of the longissimus dorsi muscle at the last rib; and (4) yield of lean meat in the right ham, calculated as a percentage of the weight of the right ham.

Analysis of the data was carried out by using multiple regression techniques. Since nearly 15 percent of the partial regression coefficients that were computed for the four carcass traits differed significantly between sexes, estimates of the relative value of the various live-hog measurements for predicting the four carcass traits were obtained separately for barrows and gilts.

RESULTS

Relative Accuracy of Live-Hog Measurements

The relative accuracy of the various live-hog measurements, including scores for market grade, is based on the correlations between single measurements obtained by the two men on the same animal. Table 1 shows that the correlations were rather high. They exceeded 0.70, except those for width over ham at 75 pounds and depth at chest at 75 and 125 pounds. They ranged from 0.63 for width over ham to 0.96 for back-fat thickness, both at 75 pounds.

TABLE 1.—*Intrasex correlations between single live-hog measurements obtained by two men on the same animal at three weights*

Item	Intrasex correlations at—		
	75 pounds	125 pounds	225 pounds
Back-fat thickness	0. 96	0. 94	0. 95
Score for market grade	. 76	. 74	. 88
Circumference at chest	. 78	. 84	. 84
Length, ear to tail	. 90	. 91	. 93
Height at shoulders	. 85	. 88	. 93
Width at shoulders	. 74	. 75	. 85
Width of middle	. 80	. 79	. 86
Width over ham	. 63	. 72	. 83
Depth at chest	. 70	. 64	. 74
Depth of middle	. 82	. 75	. 75

The correlations for score for market grade, circumference at chest, length of body, height at shoulders, width at shoulders, width of middle, width over ham, and depth at chest tended to increase with increasing body weight. This result indicates that at 225 pounds these measurements were more accurately determined than at 125 or 75 pounds. The correlations for back-fat thickness and depth of middle, on the other hand, suggest that these measurements were as accurate at 75 or 125 as at 225 pounds. At all three weights back-fat thickness was most accurately measured, whereas depth at chest was generally measured with least accuracy.

In order to minimize possible errors due to changes in the animal's position, as well as other errors of measurement, averages of the measurements obtained by the two men were used in carrying out the regression analyses.

Means and Standard Deviations

The means and standard deviations of the live-hog measurements, including scores for market grade and daily gain, are given in table 2. None of the differences at 75 pounds between sexes were significant. However at 125 and 225 pounds, barrows significantly exceeded gilts in width of middle ($P < 0.01$) and daily gain ($P < 0.01$). At 225

TABLE 2.—*Means and standard deviations of live-hog measurements at three weights for 53 barrows and 54 gilts*

Item	75 pounds				125 pounds				225 pounds			
	Barrows		Gilts		Barrows		Gilts		Barrows		Gilts	
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Back-fat thickness ____ inches	0. 73	0. 03	0. 74	0. 02	1. 13	0. 05	1. 10	0. 04	1. 96	0. 07	1. 77	0. 07
Market grade ____ score	2. 8	. 71	2. 7	. 66	3. 0	. 76	2. 5	. 77	3. 6	. 86	2. 8	. 86
Circumference at chest ____ inches	27. 6	. 51	27. 6	. 44	33. 7	. 55	33. 5	. 57	42. 5	. 72	42. 1	. 71
Length, ear to tail ____ do	29. 4	. 80	29. 7	. 79	34. 8	. 85	35. 5	. 90	41. 3	. 96	42. 1	1. 04
Height at shoulders ____ do	17. 8	. 54	17. 8	. 48	20. 8	. 65	20. 9	. 62	24. 7	. 92	25. 0	. 90
Width at shoulders ____ do	8. 2	. 27	8. 2	. 26	9. 9	. 33	9. 9	. 33	12. 2	. 44	12. 0	. 53
Width of middle ____ do	8. 6	. 36	8. 4	. 30	10. 2	. 29	9. 8	. 31	12. 0	. 32	11. 5	. 43
Width over ham ____ do	8. 2	. 26	8. 2	. 23	9. 8	. 25	9. 7	. 28	11. 6	. 33	11. 4	. 31
Depth at chest ____ do	9. 3	. 27	9. 2	. 22	11. 3	. 29	11. 3	. 26	14. 6	. 35	14. 6	. 35
Depth of middle ____ do	10. 8	. 40	10. 6	. 32	12. 9	. 34	12. 7	. 36	15. 9	. 45	15. 7	. 44
Daily gain ____ pounds	1. 17	. 12	1. 12	. 15	1. 39	. 13	1. 31	. 16	1. 57	. 15	1. 42	. 19

pounds, barrows also significantly exceeded gilts in back-fat thickness ($P < 0.01$), score for market grade ($P < 0.05$), and width over ham ($P < 0.05$), whereas gilts significantly exceeded barrows in body length ($P < 0.05$). Except for score for market grade in gilts, which differed only slightly between weights, the various measurements showed a fairly uniform upward trend with increasing body weight in both barrows and gilts.

Table 3 shows the means and standard deviations of live weight at slaughter and the carcass traits. Gilts yielded approximately 1.7 percent more lean cuts, 2.0 percent more lean meat in ham, 1.1 percent less fat cuts, and averaged 0.6 square inch more loin-eye area than barrows. These differences were all significant or highly significant. The results agree with those of other workers, notably Bruner et al. (*1958*), who reported that gilts yielded 2.3 percent more lean cuts (based on chilled carcass weight) and averaged 0.5 square inch more loin-eye area at the 10th rib than their barrow littermates.

TABLE 3.—*Means and standard deviations of live weight at slaughter and four carcass traits for 53 barrows and 54 gilts*

Item	Barrows		Gilts	
	Mean	Standard deviation	Mean	Standard deviation
Live weight at slaughter, pounds	212. 5	2. 8	212. 9	3. 6
Yield of lean cuts, percent	38. 6	1. 3	40. 3	1. 5
Yield of fat cuts, do	14. 5	1. 3	13. 4	1. 6
Loin-eye area, square inches	3. 75	. 48	4. 35	. 46
Yield of lean meat in ham, percent	54. 6	3. 9	56. 6	3. 7

Correlations Between Live-Hog Measurements and Carcass Traits

The simple correlations between live-hog measurements at the three weights and the four carcass traits are given in table 4 (page 8). Most of the correlations for back-fat thickness in barrows and gilts and width and depth of middle in gilts were significant or highly significant, whereas nearly half of those for depth of middle and daily gain in barrows and length of body in gilts were significant at the 5- or 1-percent level of probability. None of the correlations for length of body in barrows and for width at shoulders and width over ham in gilts were significant.

Although some of the correlations for barrows differed rather widely from the corresponding ones for gilts, practically all corresponding correlations that showed significance in either or both sexes were of the same sign. Also, most of the correlations between daily gain, back-fat thickness, circumference at chest, and depth of middle and yield of fat cuts were positive for both barrows and gilts, whereas those between the same live-hog measurements and the other three carcass traits were negative. Moreover, correlations for some

of the measurements, notably those for back-fat thickness in gilts, tended to increase with increasing body weight. This result indicates that at the heavier weights these measurements were slightly more accurate for predicting carcass traits than at the lighter weights.

Multiple Regression Analyses

Fractions of Variance in Carcass Traits

Estimates of the relative accuracy of the various live-hog measurements for predicting carcass traits were obtained by means of multiple regression analyses, namely by (1) including all 12 live-hog measurements in the analysis, (2) deleting daily gain and live weight at slaughter, and (3) deleting daily gain, live weight at slaughter, and each of the remaining measurements one at a time. Table 5 (page 10) shows the fractions of variance (R^2) accounted for in four carcass traits by various combinations of live-hog measurements at 75, 125, and 225 pounds.

Yield of Lean Cuts.—In table 5 the various combinations of live-hog measurements at 75 and 125 pounds generally accounted for slightly higher fractions of variance in yield of lean cuts in barrows than in gilts, whereas at 225 pounds the reverse was generally true. The results also show that the various measurements generally accounted for larger fractions of variance with increasing body weight. The variance attributed to all 12 measurements was 11 percent higher at 225 pounds than at 75 pounds. When daily gain and live weight at slaughter were omitted from the analysis, the variance accounted for was only slightly smaller. The amounts lost averaged 4, 7, and 3 percent at 75, 125, and 225 pounds, respectively.

Acting directly and indirectly with the other measurements, width over ham at 75 and 125 pounds was the most important single source of variation in yield of lean cuts in barrows, whereas depth of middle at 75 pounds and width of middle at 125 pounds were the most important sources of variation in gilts. At 225 pounds depth of middle also was the most important criterion in gilts, whereas back-fat thickness was the most important criterion in barrows. Thus depth of middle at 225 pounds, acting directly and indirectly, contributed about one-third of the variance associated with the other measurements in gilts $\frac{(0.67-0.44)}{0.67}$ when daily gain and live weight at slaughter were omitted. The corresponding fraction contributed by back-fat thickness in barrows was about one-fourth $\frac{(0.66-0.50)}{0.66}$.

In both barrows and gilts circumference at chest, width at shoulders, and depth at chest at any of the three weights had little if any value for predicting yield of lean cuts. The same was generally true for height at shoulders, as well as for width of middle at 75 and 225 pounds, width over ham at 225 pounds, length of body at 125 and 225 pounds, and depth of middle in barrows at all three weights. Score for market grade in gilts was slightly more valuable than back-fat thickness at both 75 and 125 pounds, but in neither barrows nor gilts did score for market grade at 225 pounds appear to be of any value for predicting yield of lean cuts.

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TABLE 4.—*Simple correlations between live-hog measurements and four carcass traits at three weights for barrows and gilts*

Item	Live weight of hog when measured	Correlations between live-hog measurements and—							
		Yield of lean cuts		Yield of fat cuts		Loin-eye area		Yield of lean meat in ham	
		Barrows	Gilts	Barrows	Gilts	Barrows	Gilts	Barrows	Gilts
	Pounds								
Daily gain	75	−0. 26	−0. 31*	0. 13	0. 03	−0. 22	−0. 15	−0. 32*	−0. 18
	125	−. 32*	−. 22	. 04	−. 01	−. 12	−. 07	−. 31*	−. 24
	225	−. 30*	−. 40**	−. 04	. 04	−. 12	−. 08	−. 30*	−. 38**
Live weight at slaughter		−. 27*	−. 35*	. 25	. 18	−. 12	−. 12	−. 26	−. 27*
Back-fat thickness	75	−. 53**	−. 19	. 77**	. 38**	−. 40**	−. 29*	−. 55**	. 03
	125	−. 56**	−. 32*	. 78**	. 69**	−. 41**	−. 43**	−. 46**	−. 27*
	225	−. 65**	−. 58**	. 76**	. 74**	−. 43**	−. 49**	−. 52**	−. 61**
Score for market grade	75	. 05	. 03	−. 02	. 10	. 31*	−. 17	. 03	−. 06
	125	−. 21	−. 06	. 30*	. 31*	. 05	−. 18	−. 25	−. 37**
	225	−. 23	−. 24	. 24	. 34*	−. 02	−. 20	−. 32*	−. 24
Circumference at chest	75	−. 04	−. 03	. 16	. 07	−. 02	−. 02	−. 21	−. 09
	125	−. 09	−. 07	. 28*	. 28*	−. 09	−. 19	−. 03	−. 02
	225	−. 30*	−. 30*	. 41**	. 46**	−. 10	−. 24	−. 10	−. 23

Length, ear to tail	75	−. 14	. 14	. 12	−. 22	−. 20	. 08	−. 17	. 24
	125	−. 04	. 19	−. 02	−. 35*	. 22	. 16	. 03	. 41**
	225	. 01	. 31*	−. 12	−. 41**	−. 03	. 26	. 04	. 29*
Height at shoulders	75	. 22	. 08	−. 18	−. 12	−. 08	. 14	. 18	. 20
	125	. 25	. 28*	−. 13	−. 16	−. 03	. 12	. 38**	. 28*
	225	. 29*	. 10	−. 18	−. 07	−. 02	. 10	. 36**	. 24
Width at shoulders	75	. 21	. 00	−. 25	−. 07	. 28*	−. 01	−. 08	−. 10
	125	. 08	−. 08	−. 13	. 13	. 21	−. 21	−. 05	−. 12
	225	−. 01	−. 16	−. 13	. 14	. 23	−. 12	−. 19	−. 13
Width of middle	75	−. 14	−. 18	. 12	. 23	. 11	−. 17	−. 08	−. 45**
	125	−. 33*	−. 32*	. 27*	. 54**	−. 08	−. 41**	−. 04	−. 42**
	225	−. 27*	−. 40**	. 13	. 40**	. 05	−. 26	−. 20	−. 34**
Width over ham	75	. 39**	. 23	−. 31*	−. 20	. 33*	. 20	. 19	. 03
	125	. 28*	. 26	−. 08	−. 05	. 26	. 02	. 01	. 02
	225	. 23	. 01	. 00	. 03	. 15	. 08	−. 10	. 03
Depth at chest	75	−. 02	−. 19	. 02	. 24	−. 07	−. 21	−. 10	−. 15
	125	. 05	−. 03	. 11	. 30*	−. 09	−. 20	. 09	. 03
	225	−. 18	−. 23	. 30*	. 34*	−. 23	−. 13	. 00	−. 09
Depth of middle	75	−. 40**	−. 56**	. 39**	. 52**	−. 17	−. 41**	−. 48**	−. 54**
	125	−. 08	−. 48**	. 02	. 49**	. 00	−. 36**	−. 16	−. 36**
	225	−. 46**	−. 66**	. 21	. 45**	−. 20	−. 27*	−. 27*	−. 41**

*Significant at 5-percent level.
**Significant at 1-percent level.

TABLE 5.—*Fractions of variance (R^2) accounted for in four carcass traits by various combinations of live-hog measurements at three weights for barrows and gilts*

Item	YIELD OF LEAN CUTS						YIELD OF FAT CUTS					
	Fractions of variance (R^2) at—						Fractions of variance (R^2) at—					
	75 pounds		125 pounds		225 pounds		75 pounds		125 pounds		225 pounds	
	Barrows	Gilts	Barrows	Gilts	Barrows	Gilts	Barrows	Gilts	Barrows	Gilts	Barrows	Gilts
All 12 live-hog measurements	0. 60**	0. 56**	0. 69**	0. 62**	0. 68**	0. 71**	0. 72**	0. 58**	0. 71**	0. 73**	0. 75**	0. 76**
All except daily gain and live weight at slaughter	. 57**	. 50**	. 63**	. 54**	. 66**	. 67**	. 72**	. 53**	. 65**	. 68**	. 68**	. 72**
All except daily gain, live weight at slaughter, and—												
Back-fat thickness	. 48*	. 47*	. 56**	. 54**	. 50**	. 59**	. 42*	. 43*	. 44*	. 54**	. 37*	. 49**
Score for market grade	. 57**	. 45*	. 62**	. 49**	. 66**	. 66**	. 69**	. 52**	. 65**	. 68**	. 68**	. 71**
Circumference at chest	. 55**	. 50**	. 63**	. 52**	. 64**	. 67**	. 72**	. 53**	. 65**	. 68**	. 66**	. 71**
Length, ear to tail	. 55**	. 41*	. 61**	. 54**	. 61**	. 67**	. 72**	. 46*	. 65**	. 68**	. 62**	. 72**
Height at shoulders	. 56**	. 49**	. 60**	. 45*	. 66**	. 67**	. 71**	. 53**	. 65**	. 67**	. 66**	. 72**
Width at shoulders	. 57**	. 48**	. 63**	. 54**	. 65**	. 67**	. 71**	. 53**	. 65**	. 66**	. 68**	. 68**
Width of middle	. 53**	. 50**	. 53**	. 40*	. 64**	. 64**	. 70**	. 53**	. 65**	. 61**	. 67**	. 71**
Width over ham	. 47*	. 44*	. 45*	. 48*	. 62**	. 66**	. 70**	. 47*	. 63**	. 65**	. 66**	. 70**
Depth at chest	. 56**	. 50**	. 62**	. 54**	. 65**	. 67**	. 72**	. 52**	. 65**	. 67**	. 68**	. 72**
Depth of middle	. 54**	. 29	. 63**	. 50**	. 63**	. 44*	. 71**	. 43*	. 64**	. 68**	. 68**	. 69**

	LOIN-EYE AREA						YIELD OF LEAN MEAT IN HAM					
All 12 live-hog measurements	.45*	.34	.31	.36	.33	.34	.60**	.47*	.41	.40	.43*	.55**
All except daily gain and live weight at slaughter	.40*	.34	.31	.34	.33	.32	.59**	.45*	.34	.38	.42*	.53**
All except daily gain, live weight at slaughter, and—												
Back-fat thickness	.24	.30	.21	.30	.22	.22	.42*	.44*	.25	.38	.23	.38*
Score for market grade	.32	.32	.30	.32	.31	.32	.56**	.42*	.34	.37	.42*	.53**
Circumference at chest	.40*	.31	.30	.34	.32	.32	.58**	.45*	.33	.38	.42*	.53**
Length, ear to tail	.39*	.34	.27	.34	.32	.32	.59**	.40*	.33	.37	.36	.53**
Height at shoulders	.39*	.34	.31	.33	.30	.32	.58**	.44*	.29	.37	.41*	.51**
Width at shoulders	.40*	.33	.30	.33	.31	.31	.54**	.44*	.34	.36	.38*	.50**
Width of middle	.40*	.33	.29	.24	.30	.32	.54**	.41*	.33	.35	.42*	.52**
Width over ham	.40*	.28	.28	.31	.33	.27	.59**	.43*	.33	.36	.41*	.49**
Depth at chest	.40*	.31	.31	.33	.32	.32	.58**	.44*	.34	.38	.42*	.52**
Depth of middle	.39*	.28	.30	.34	.29	.31	.47*	.31	.33	.34	.42*	.48**

*Significant at 5-percent level.
**Significant at 1-percent level.

Yield of Fat Cuts.—The 12 live-hog measurements accounted for 72, 71, and 75 percent of the variance in yield of fat cuts in barrows and for 58, 73, and 76 percent in gilts at 75, 125, and 225 pounds, respectively, as shown in table 5. These values exceed the corresponding ones for yield of lean cuts by amounts varying from 2 to 12 percent. This result indicates that yield of fat cuts was predicted with slightly greater accuracy than yield of lean cuts. At 75 pounds the various combinations of measurements generally accounted for considerably larger fractions of variance in barrows than in gilts, whereas at 125 and 225 pounds slightly larger fractions were generally accounted for in gilts. These results agree with those for yield of lean cuts at 75 and 225 pounds, whereas at 125 pounds the reverse was true. However, the various combinations of measurements in barrows showed little if any gain in predictive value with increasing body weight, whereas in gilts there was a rather marked increase from 75 to 125 pounds and less increase from 125 to 225 pounds. When daily gain and live weight at slaughter were omitted from the analysis, the variance accounted for by the remaining measurements was lower by amounts ranging from 0 to 7 percent in barrows and from 4 to 5 percent in gilts.

At all three weights back-fat thickness, acting directly and indirectly with the other measurements, was the most important source of variation in yield of fat cuts. When daily gain and live weight at slaughter were omitted from the analysis, back-fat thickness contributed about 30, 21, and 31 percent to the variance that could be ascribed to all measurements in barrows and 10, 14, and 23 percent in gilts.

The variance attributable to the other live-hog measurements amounted to only about 4 percent of the variance accounted for by the combined effects of all measurements at each of the three weights. Also the fractions of variance accounted for when score for market grade was omitted were for all practical purposes identical with those when score for market grade was included. Thus, except for back-fat thickness, none of the other measurements if used singly would have much practical value for estimating the yield of fat cuts.

Loin-Eye Area.—Table 5 shows that the 12 live-hog measurements generally did not account for as large a fraction of variance in loin-eye area as they did in yield of lean or yield of fat cuts. Thus only 45, 31, and 33 percent of the variance in barrows and 34, 36, and 34 percent of the variance in gilts could be explained by the 12 measurements at 75, 125, and 225 pounds, respectively. However, in agreement with the results for yield of lean and yield of fat cuts, the various combinations of measurements at 75 pounds generally accounted for slightly greater fractions of variance in barrows than in gilts. At the two heavier weights, on the other hand, the variance for the various measurements differed little between sexes.

In agreement with the results for yield of fat cuts in barrows, the various measurements at 75 pounds were as accurate criteria for estimating loin-eye area as at the heavier weights. Thus nothing would seem to be gained by obtaining measurements at heavier weights if used to estimate loin-eye area. When daily gain and live weight at slaughter were omitted from the analysis, the fractions of variance were reduced only slightly. The decrease for the measurements taken at 75, 125, and 225 pounds amounted to 5, 0, and 0 percent, respectively, for barrows and 0, 2, and 2 percent for gilts.

At all three weights back-fat thickness was the most important single factor for estimating loin-eye area in barrows. It accounted for about 16, 10, and 11 percent of the variance associated with the other measurements when daily gain and live weight at slaughter were omitted. In gilts, width over ham and depth of middle were the most important factors at 75 pounds. Each contributed about 6 percent to the variance associated with all 12 measurements combined. At 125 pounds width of middle contributed most to the variance in gilts, and at 225 pounds back-fat thickness contributed most. The variance contributed by these measurements was 10 percent at the two weights. Circumference at chest, length of body, height at shoulders, width at shoulders, and depth at chest if considered singly contributed little if anything to the variance in either barrows or gilts. In barrows at 75 pounds score for market grade was the second most important factor affecting variance in loin-eye area, but it was practically worthless in gilts at 75 pounds and in both barrows and gilts at 125 and 225 pounds.

Yield of Lean Meat in Ham.—The 12 live-hog measurements accounted for 60, 41, and 43 percent of the variance in yield of lean meat in ham in barrows and 47, 40, and 55 percent in gilts at 75, 125, and 225 pounds, respectively, as shown in table 5. These values exceed those for loin-eye area by 4 to 21 percent, but they are lower than the corresponding ones for yield of lean and yield of fat cuts. The variance attributed to the various combinations of measurements at 75 pounds was greater in barrows than in gilts, whereas at 125 and 225 pounds generally larger fractions of variance were accounted for in gilts. When daily gain and live weight at slaughter were omitted from the analysis, the fractions of variance were reduced 1, 7, and 1 percent in barrows at 75, 125, and 225 pounds, respectively, and 2 percent in gilts at all weights.

At all three weights back-fat thickness was the most important source of variation in yield of lean meat in ham in barrows. The same was true for gilts at 225 pounds. In barrows depth of middle at 75 pounds, height at shoulders at 125 pounds, and length of body at 225 pounds were second in importance and accounted for 12, 5, and 6 percent of the variance after daily gain and live weight at slaughter were omitted. In gilts at 125 pounds none of the measurements considered singly contributed more than 4 percent to the fractions of variance. Although score for market grade at 75 pounds accounted for 3 percent of the variance in both barrows and gilts, it contributed practically nothing at the other weights.

Partial Regression Coefficients

Table 6 gives the partial regression coefficients for each live-hog measurement at 225 pounds for estimating the four carcass traits. The partial regression coefficients for back-fat thickness and depth of middle are positive for yield of fat cuts in both sexes, and they are negative for the other three carcass traits. Within the limits of these data the partial regression coefficients indicate, for example, that in barrows for each increase of one-tenth inch in back-fat thickness, the yield of lean cuts may decrease 0.2 percent; likewise, in barrows for each increase of one-tenth inch in width over ham, the yield of fat cuts may increase 0.02 percent.

TABLE 6.—*Partial regression coefficients and fractions of variance (R^2) for live-hog measurements at 225 pounds for barrows and gilts for predicting four carcass traits*

Item	Partial regression coefficients for predicting—							
	Yield of lean cuts		Yield of fat cuts		Loin-eye area		Yield of lean meat in ham	
	Barrows	Gilts	Barrows	Gilts	Barrows	Gilts	Barrows	Gilts
Daily gain	0. 65	−1. 78	−2. 82**	−2. 38*	−0. 29	0. 48	−1. 17	−2. 33
Live weight at slaughter	−. 08	−. 03	. 06	. 01	. 00	−. 01	−. 17	−. 11
Back-fat thickness	−1. 99**	−1. 49**	2. 99**	3. 21**	−. 69*	−. 65	−6. 86**	−5. 24**
Score for market grade	−. 02	−. 23	. 19	. 03	−. 07	. 01	−. 13	−. 12
Circumference at chest	−. 16	. 08	. 20	. 12	. 07	−. 01	. 15	−. 34
Length, ear to tail	−. 18	−. 06	. 27**	. 01	−. 03	. 02	−. 65	. 03
Height at shoulders	. 07	−. 17	. 12	−. 13	−. 07	. 04	−. 01	. 29
Width at shoulders	−. 13	. 23	−. 03	−. 42*	. 10	. 05	−1. 04	1. 04
Width of middle	−. 39	−. 42*	−. 18	. 19	. 19	−. 04	. 02	−. 56
Width over ham	. 70*	. 37	. 24	−. 46	−. 04	. 22	−. 56	1. 50
Depth at chest	. 21	. 01	−. 23	. 14	−. 06	. 04	. 01	. 71
Depth of middle	−. 33	−. 88**	. 20	. 52**	. 10	−. 08	−. 06	−. 85
	Fractions of variance (R^2)							
All 12 live-hog measurements	. 68**	. 71**	. 75**	. 76**	. 33	. 34	. 43*	. 55**

* Significant at 5-percent level.
** Significant at 1-percent level.

DISCUSSION

Although the 12 live-hog measurements accounted for fairly large fractions of variance in yield of fat cuts, there was still about 24 to 42 percent of the variance that was due to causes not revealed by the measurements studied. The amount of total variance unaccounted for by the measurements studied was larger for yield of lean cuts, loin-eye area, and yield of lean meat in ham than for yield of fat cuts (table 5). It ranged from 29 to 44, 55 to 69, and 40 to 60 percent for the three traits, respectively.

Back-fat thickness at all three weights for the 107 hogs measured was generally more accurate for predicting carcass traits in barrows than any other single measurement at corresponding weights. Back-fat thickness at all three weights was also the most accurate single measurement for predicting yield of fat cuts in gilts. At 225 pounds it also excelled any other single measurement in predicting the other carcass traits. At 75 and 125 pounds, on the other hand, depth of middle, width of middle, and width over ham gave better results for predicting the remaining carcass traits than back-fat thickness. In both barrows and gilts length of body, height at shoulders, width at shoulders, circumference at chest, and depth at chest when considered singly were least accurate in predicting the four carcass traits.

Score for market grade also was of little value for predicting carcass traits, except possibly at 75 pounds for loin-eye area in barrows and at 75 and 125 pounds for yield of lean cuts in gilts.

SUMMARY

Live-hog measurements of 107 crossbred barrows and gilts at 75, 125, and 225 pounds were studied to determine the relative accuracy of back-fat probes, scores for market grade, and various body measurements for estimating carcass value.

Collectively the 12 live-hog measurements at all three weights studied were generally most accurate for estimating yield of fat cuts, followed by yield of lean cuts, yield of lean meat in ham, and loin-eye area in that order.

The various combinations of measurements were generally more accurate for predicting yield of lean and yield of fat cuts at 225 pounds than at 125 or 75 pounds. However, for predicting loin-eye area and yield of lean meat in ham, they were slightly more accurate at 75 pounds than at the heavier weights. The results suggest that measurements taken at lighter weights may have some value for predicting differences in certain carcass traits.

Back-fat thickness generally was the most important item for predicting individual differences in the four carcass traits, although some of the other measurements at the lighter weights were slightly more accurate. Score for market grade had little predictive value at any of the three weights, except possibly at 75 and 125 pounds. At these weights it was slightly more accurate for predicting yield of lean cuts and yield of lean meat in ham in gilts than was back-fat thickness. The results thus suggest that at 225 pounds and at lighter weights back-fat thickness constitutes the best single measurement for estimating meatiness in hogs, followed by depth of middle, width of middle, width over ham, and score for market grade in that order.

LITERATURE CITED

ANDREWS, F. N., and WHALEY, R. M.
1955. MEASURE FAT AND MUSCLE IN LIVE ANIMAL AND CARCASS. *In* Agricultural Research in Indiana. Ind. Agr. Expt. Sta. Ann. Rpt. 68, 154 pp.

BRATZLER, L. J., and MARGERUM, E. P., JR.
1953. THE RELATIONSHIP BETWEEN LIVE HOG SCORES AND CARCASS MEASUREMENTS. Jour. Anim. Sci. 12: 856–858.

BRUNER, W. H., CAHILL, V. R., ROBISON, W. L., and WILSON, R. F.
1958. PERFORMANCE OF BARROW AND GILT LITTERMATE PAIRS AT THE OHIO SWINE EVALUATION STATION. Jour. Anim. Sci. 17: 875–878.

DE PAPE, J. G., and WHATLEY, J. A., JR.
1956. LIVE HOG PROBES AT VARIOUS SITES, WEIGHTS, AND AGES AS INDICATORS OF CARCASS MERIT. Jour. Anim. Sci. 15: 1029–1035.

HANKINS, O. G., and HINER, R. L.
1937. A PROGRESS REPORT ON THE MEAT YIELDS OF DANISH LANDRACE HOGS IN COMPARISON WITH CERTAIN AMERICAN BREEDS. Amer. Soc. Anim. Prod. Proc. 1937: 255–259.

HARRINGTON, G.
1958. PIG CARCASS EVALUATION. Commonwealth Bur. Anim. Breeding and Genet. Tech. Commun. 12, 107 pp.

HAZEL, L. N., and KLINE, E. A.
1952. MECHANICAL MEASUREMENT OF FATNESS AND CARCASS VALUE ON LIVE HOGS. Jour. Anim. Sci. 11: 313–318.

——— and KLINE, E. A.
1953. ACCURACY OF EIGHT SITES FOR PROBING LIVE PIGS TO MEASURE FATNESS AND LEANNESS. Jour. Anim. Sci. 12: 894–895.

HETZER, H. O., HANKINS, O. G., KING, J. X., and ZELLER, J. H.
1950. RELATIONSHIP BETWEEN CERTAIN BODY MEASUREMENTS AND CARCASS CHARACTERISTICS IN SWINE. Jour. Anim. Sci. 9: 37–47.

——— ZELLER, J. H., and HANKINS, O. G.
1956. CARCASS YIELDS AS RELATED TO LIVE HOG PROBES AT VARIOUS WEIGHTS AND LOCATIONS. Jour Anim. Sci. 15: 257–270.

HINER, R. L.
1949. STANDARD METHOD OF CUTTING PORK CARCASSES FOR DETERMINING THE YIELD AND PERCENTAGE OF WHOLESALE CUTS. Reciprocal Meat Conf. Proc. 2: 123–131.

PHILLIPS, R. W., and DAWSON, W. M.
1936. A STUDY OF METHODS FOR OBTAINING MEASUREMENTS OF SWINE. Amer. Soc. Anim. Prod. Proc. 1936: 93–99.

ROBISON, O. W., COOKSEY, J. H., CHAPMAN, A. B., and SELF, H. L.
1960. ESTIMATION OF CARCASS MERIT OF SWINE FROM LIVE ANIMAL MEASUREMENTS. Jour. Anim. Sci. 19: 1013–1023.

TUMA, H. J., MERKEL, R. A., and MACKINTOSH, D. L.
1958. CORRELATION BETWEEN LIVE HOG SCORES AND CARCASS MEASUREMENTS. Jour. Anim. Sci. 17: 1158.

U.S. DEPARTMENT OF AGRICULTURE, AGRICULTURE MARKETING SERVICE.
1952. OFFICIAL UNITED STATES STANDARDS FOR GRADES OF SLAUGHTER SWINE (BARROWS AND GILTS; SOWS). Serv. and Regulat. Announc. 172, 7 pp.

U.S. GOVERNMENT PRINTING OFFICE: 1962